

# The Impact of Virtual Labs during the Pandemic Period

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Tagged in [Higher Education](#), [Pandemic Response](#)

## Summary

The need to do college laboratory experiments in science and engineering remotely due to the COVID 19 Pandemic became necessary for the entire student community, from March 2021 onward. The Virtual Lab repository built under the NMEICT Program of the Ministry of Education, Government of India, was leveraged for use by students to do simulated experiments. The Virtual Labs made a substantial impact and was used by over 7.0M users to meet their curricular needs. This chapter describes the salient features of the impact and how this impact can be sustained through specific initiatives.

## Full Article

### INTRODUCTION

Laboratory experiments form an integral part of the curriculum of every science and engineering student. As on March 2021, "India annually produces one million engineering graduates, has 3500 engineering colleges, 3400 polytechnics, and 200 schools of planning and architecture, and many times more industrial training institutes". [1] Each engineering college student is expected to cover 160-170 credits [2] during the undergraduate program of 4 years of which 20-25% credits come from practicals and laboratory experiments done during the course [3] At a high level this translates to 7-8 hours of practical work per working week. Informal understanding of this implies each student does about 10 experiments per subject per semester physically in college laboratories, as a curricular requirement. The contribution of doing experiments to understanding and learning is definite and hence their importance. Given the scenario imposed by the Pandemic and frequent lockdowns after 25<sup>th</sup> March 2020, reaching college laboratories physically has been a major constraint for the student. This became a constraint for lecture and tutorial sessions too for colleges and educational institutes across the globe.

Online learning programs have been in use since many years, but more as a supplement to the formal graduate and undergraduate courses. During the pandemic period, with some innovation, existing tools were adopted and classes conducted online in most engineering colleges. Also, this met the requirements of state education boards. For doing lab experiments, use of online simulated Virtual experiments presented an immediate alternative.

Questions on their effectiveness, availability, alignment to the curriculum and the

mechanisms to reach out to the large number of students are, however, points that need understanding.

## Objectives

We examine the impact that the *Virtual Labs*, of the Ministry of Education, Government of India [4] has had on engineering colleges and how it enabled online simulated practicals being done by the students during the pandemic. How this need was met by the *Virtual Labs* and the accompanying outreach activities, is the main focus. The impact will be assessed using data from the *Virtual Lab Portal*, data from *Google Analytics*, survey results and feedback data from users.

## About Virtual Labs

Online laboratories are known to strongly aid learning in science [5]. The *Virtual Labs* [4], built under the National Mission on Education through Information and Communication Technology (NMEICT) program of the Ministry of Education [6] of the Government of India, is a repository of over 140 labs, containing more than 1400 simulated experiments [7] “Physical distances and the lack of resources often make it difficult for students to perform experiments, especially when they involve sophisticated instruments. Also, good teachers are always a scarce resource. The Virtual Labs project addresses the issue of lack of good lab facilities, as well as trained teachers, by making remote and simulation based experimentation possible through World Wide Web.”[8]

These labs have been developed by a consortium of eleven academic institutes since 2009. They span 13 science and engineering disciplines and are aligned with several undergraduate courses in those disciplines. The labs are available free at <https://vlab.co.in>, and do not require a login. The source code for almost all the labs is available on GitHub at <https://github.com/virtual-labs>. With over 1.0 million (1.0M) students graduating from Indian engineering colleges every year, *Virtual Labs* aim to provide a strong supplement to laboratory experiments for these students and the other 3.0M pursuing the courses.

Before the Pandemic started i.e., between July 2014 and March 2020, over 0.3M students and faculty performed 3M person experiments (Usages) using *Virtual Labs*. A Network of over 1000 committed colleges as nodal centres, interested in using these experiments have benefited from this portal.[9] Students and Faculty were introduced to the portal via face to face workshops conducted by the *Virtual Labs Outreach Program*. Each experiment is a self-contained resource of theory, simulation, and self-assessment enabling the student to perform the experiment anywhere anytime free of cost. The virtual experiments enhance the overall experience of doing physical experiment. The enhancement of learning and concepts is achieved by allowing students to repeat, play around with data and procedure and do what-if analysis. At the same time many experiments can be used

standalone in domains such as computer science. Even in normal circumstances, doing virtual experiments eliminate constraints on time, schedule and space. The repository of experiments has been constantly improved in scope and range by adding new experiments each year since 2014. From an engineering college perspective Virtual Labs is one of the largest repositories of experiments available to students in the country.

## IMPACT OF VIRTUAL LABS

Among the many parameters that signify the impact of the *Virtual Labs* are:

1. The usage as number of person experiments
2. Number of users and extent of engagement
3. Spread of usages in terms geography and domains,
4. Satisfaction of the users

The major factors that have influenced the impact of *Virtual Labs* on the students and faculty have been relevance and alignment of the experiments to curricula, faculty mandates, and student motivation, physical and local constraints due to the pandemic. Alignment of *Virtual Labs* varies with different domains. For instance, 83% of the labs mentioned in the curricula of Computer Science are available as simulated experiments on the portal. [10]

### ***Enthusing students in the use of Virtual Labs***

The usage of *Virtual Labs* experiments till March 2020 was primarily driven by an accompanying outreach program, which ran workshops across colleges in the country. Over 2,000 workshops were conducted and over 2.8 million usages of virtual labs were reported. While these are good numbers, given the size of the student population, much more can be done. Since March 2020, however, with the advent of COVID-19, and the subsequent closure of colleges and migration to online teaching, this outreach model has been significantly attenuated. This has been accompanied, however, by a dramatic increase in usage. The user base of *Virtual Labs* went up as reported in subsequent paras, having more than 49 million cumulative page views as of August 2021.

The pandemic period has imposed a certain compulsion on the colleges, students and the faculty to use virtual experiments to meet the needs of the curriculum. However, it is important for them to note that the benefit in doing virtual lab experiments goes beyond just meeting curricular requirements and enhancing learning. This was adequately conveyed to the students and faculty through workshops and Nodal Centres. Motivation of the users is therefore for sustaining the interest and use of the portal. This is triggered and nurtured by good experience and a comfort in the usability of the *Virtual Labs* Portal, in addition to the need to do experiments. In summary, the impact it has on the increase in usage and other metrics is significant. "The average motivation which was 5.39 (out of

10) at start improved to 8.31 at the end of conducting 15 experiments”. [11] This approach has been extended to the students even during the pandemic period and surveys show that 52.8% of the students use *Virtual Labs* Portal out of their own interest. [12].

### ***Parameters measuring usage***

The main parameters measuring the usage of *Virtual Labs* are:

Page View – the total number of pages loaded or reloaded in browser. [13]

User – a visitor to a web page who is identified by a unique code (browser cookies) that is auto-generated by the analytics tracking system. [13]

### ***Spread of Virtual Labs usage***

Usage is a significant metric on the impact the portal has on the students and faculty. The following section describes the nature of impact. Table 1 gives the combined Impact details and their causes. The common factors causing contributing to the impact are: the need to complete the curricula, faculty support, the push from the Virtual Labs online webinars and increase in interest among students and faculty.

### ***Usage during the Pandemic***

During the pandemic period the schedules were erratic and changed with short notice. High uncertainty cluttered the schedules of classes and exams and made it difficult to do experiments in college labs. For instance, out of a 16 month period from April 2020 to August 2021, only 3 months were available for students to do experiments in Andhra Pradesh. Accordingly, the *Virtual Labs* option was used and the overall usage grew steadily. Over the period, the overall cumulative page views grew from 1.35M to 49.6M.

### ***Spread of usage across domains***

Before the pandemic started, the perception of a large number of faculty and students was that virtual experiments are relevant only to computer science and engineering and not useful to other domains ~~were not useful~~, as they involved equipment to do experiments. Accordingly, experiments from computer science were the first and the second in the list of top 10 labs used. Due to the pandemic the need to do experiments in non-computer science domains was high and the previously held ~~This~~ perception changed after students used simulated experiments. Today the top 10 labs are from other domains with “Digital Electronics Lab” being the most used lab and computer science labs moving in and out of the top 10 labs. The user community has grown from 0.3M users to 6.9M.

Thus, users from all domains have are benefitted from the *Virtual Labs*.

### ***Geographical Spread of Virtual Lab usage:***

As a result of the increased need and the relevance of *Virtual Labs*, all the three parameters that increase the spread of usage – number of nodal centers, workshops and participants, increased. Colleges that chose to join the Nodal Center network by choice, committed themselves to use the *Virtual Labs*. Outreach teams conducted workshops to introduce the students and faculty, resulted in a sustained use of the same. Usages from such workshops and webinars are a small percentage of the usages happening due to interest of the participants. This is an indicator of the extent of sustained self motivated usage of the portal. This is a significant indicator at 8.5%.

#	Impact Parameter	Before Mar 2020	After Pandemic
1	Virtual Lab usages	1.35 M	49.6M (Cumulative)
2	Usage Domains	Largely Computer Science	All Domains
3	Geographical spread a) Nodal Centres b) Workshops c) Participants		46% increase 66% increase 66% increase

TABLE 1 IMPACT OF VIRTUAL LAB DURING PANDEMIC

## **CONCLUSION AND FURTHER WORK**

The *Virtual Labs* has made a significant impact on the student community by providing the bridge in doing experiments to meet the curricular requirement, otherwise not physically possible due to the pandemic. *Virtual Labs* has been used by over 7.0M users resulting in over 49M page views. Inclusion in the *model curriculum of NEP (?)* and the agility of the *Virtual Labs* infrastructure by scaling multiple times, have enabled this. The increase in usage and users, the spread across more domains and the rapid rise in nodal centers reflect the impact of the

Virtual Labs. However, the gaps for further adoption lie in aligning the capability of virtual labs infrastructure to the college processes such as dashboards to record and assess experiment performance by students and buy-in from universities to include *Virtual Labs* in the curricula. Significant work still remains to be done to sustain the impact of the *Virtual Labs* in the coming years. Rapidly pushing the crowdsourcing of experiment development using college faculty as subject matter experts are also potential areas of work.

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**This article is part of a Confluence series called “Still Online: Higher Education in India”. The remaining articles of the series can be found [here](#).**